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METHOD AND TOOL FOR PRODUCING COUNTERSUNK HOLES OR DOWEL HOLES IN A METAL SHEET
[VERFAHREN UND WERKZEUG ZUM HERSTELLEN VON SENKLÖCHERN ODER PASSLÖCHERN IN EINEM BLECH]

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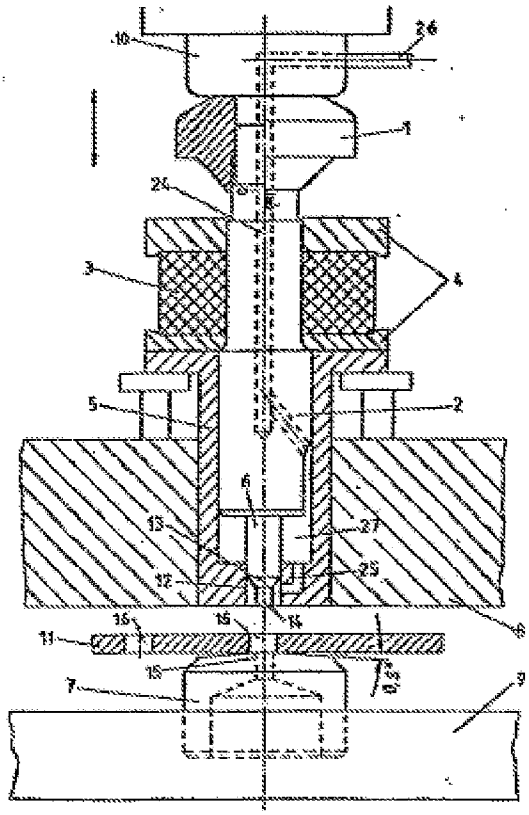

Fig. 1

CLAIMS /1*

1. Method for producing countersunk holes in a metal sheet, characterized in that first a hole is punched in the sheet metal, the inner diameter of which is somewhat larger than the inner diameter of the desired countersunk hole and then, in this punched hole, the desired countersunk hole is stamped with a stamping die with a shape corresponding to the desired countersunk hole.

2. Method for manufacturing dowel holes in a metal sheet, characterized in that first a hole is punched in the metal sheet, the inner diameter of which is somewhat smaller than the desired inner diameter of the dowel hole and then in this punched hole the desired dowel hole is stamped with a stamping die corresponding to the diameter of the desired dowel hole resulting in material displacement.

3. Method according to Claim 1 or 2, characterized in that during the stamping process, the metal sheet is held clamped between a die contacting the reverse side of the metal sheet and a hold down that is pressed on the upper side of the metal sheet such that when it is /2 displaced, the material is not pressed over the upper side or the underside of the metal sheet.

4. Method according to Claim 1 or 3, characterized in that the inner diameter of the punched hole is selected so it is about 10 to 40% larger than the desired inner diameter of the countersunk hole.

5. Method according to Claim 2 or 3, characterized in that the inner diameter of the punched hole is selected so it is about 5 to 10% smaller

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than the desired inner diameter of the dowel hole.

6. Method according to one or more of the preceding claims, characterized in that during the stamping process, lubricant is supplied to the stamping die.

7. Tool for carrying out a method according to Claims 1 to 6 by means of a press suitable for holding punching tools, in particular an NC punching machine, characterized by a die holder (2) guided in a hold down (5) as in punching machines, on which the stamping die (6, 23) is mounted that corresponds in its contour to the desired countersunk or dowel hole (18, 19, 20, 22) and is guided in the opening (12) of the hold down (5).

8. Tool according to Claim 7, characterized in that the counter- /3 sink stamping die (6) with its upper shaft that connects to the mold section (13) that stamps the countersink, is guided with narrow play in the hold down opening (12) that is shaped corresponding to this shaft cross section.

9. Tool according to Claim 7 or 8, characterized in that the opening (15) of the die (7) provided on the underside has a cross section such that the mold section(14) of the countersink stamping die (6) that stamps the hole is guided in it with little play.

10. Tool according to Claims 7 to 9, characterized in that the dowel hole stamping die (23) is guided in the hold down opening (12) with little play.

11. Tool according to Claim 10, characterized in that the edge of the dowel hole stamping die (23) is rounded.

12. Tool for carrying out a method according to Claims 1 to 6 by means of a press suitable for holding an upper punching tool and a lower

countering tool, especially an NC punching machine, characterized in that the countering tool is a fixed stamping die with a contour shape corresponding to the desired countersunk or dowel hole (18, 19, 20, 22) with associated flexible stripper and the hold down of the upper punching tool is designed as a die.

13. Tool according to one or more of the preceding Claims 6 to 12, characterized in that for forming the countersink on both sides, a stamping die that corresponds in its contour shape to the desired countersunk hole is provided both on the upper punching tool and on the lower countering tool. /4

14. Tool according to one or more of the preceding Claims 7 to 13, characterized in that the upper side of the die (7) and/or the die holder acting as a die is slightly curved in the direction of the stamping die (6, 23).

15. Tool according to one or more of the preceding Claims 7 to 14, characterized in that, as in punching tools, the hold down (5) cooperates by way of a spring element (3) with the die holder (2) in such a way that during the stamping process, the hold down (5) is held pressed onto the upper side of the sheet metal with a force determined by the spring element (3).

16. Tool according to one or more of the preceding Claims 7 to 15, characterized in that the edge of the hold down opening (12) and/or of the die opening (15) is designed with sharp edges.

17. Tool according to one or more of the preceding Claims 7 to 16, characterized in that the countersinking depth of the die holder (2) /5

is adjustable.

18. Stamping tool for use in NC punching machines, especially according to one or more of the preceding Claims 7 to 17, characterized in that on the end of the die holder (2) that interacts with the ram (10), an adjusting screw (1) with an associated adjusting scale is mounted.

19. Tool according to one or more of the preceding Claims 7 to 18, characterized in that in the die holder (2) and/or stripper (5) a channel (24, 25) is formed for supplying lubricating oil to the stamping die (6, 23).

DESCRIPTION /6

The invention relates to a method for producing countersunk holes or dowel holes in a metal sheet and a tool for carrying out such a method.

In sheet metal parts, as they are used e.g. in constructing electrical devices, it is often necessary to form holes with a specific countersink, for example with a countersink for countersunk screws, cylinder bolts, nuts, rivets, rivet nuts, etc. Also during production of threaded holes in such a metal sheet, it is necessary to provide the predrilled or prepunched hole with a specific countersink on one or both sheet metal sides before cutting the thread so that during thread cutting no projecting burrs develop. Previously, countersunk holes of this type were manufactured in that first a hole was drilled or punched in the sheet metal, the inner diameter of which is equal to the desired inner diameter of the countersunk hole and then in a subsequent cutting machining step, the countersink with the desired shape was drilled and/or milled into the predrilled or prepunched hole. This type of manufacturing is relatively complicated and expensive; above all it is not suited to the so-called NC punching machines that have recently been used more and more for sheet metal processing. With such NC punching machines, work pieces of a specific size are punched fully automatically out of a metal sheet with /7 various types of punches; to do this all different types of punching tools are brought into action automatically with a revolving plate or with a fast change system. With such a punching machine, it was actually possible to punch cylindrical holes in any size at any location on the work piece; if a countersink was required in a hole, previously this could only be

produced in a subsequent cutting machining step on a different machine. The time required for this is considerable, thus the known method is very expensive and in addition the countersinking cutting tool has to be sharpened continuously and in fact with different grinds depending on the material (clearance angle).

Stamping slight indentations on sheet metal parts by a stamping process is actually known, possibly also in connection with a corresponding hole. However in this case, the hole is curved out toward the reverse side and this method would not be suitable for producing countersunk holes in which the sheet metal in the area of this countersunk hole has to be completely plane parallel on the upper side and on the reverse side.

In a similar manner, it is often necessary to form dowel holes in sheet metal parts, the diameters of which must correspond to the tolerances specified for this and that additionally have to be in a precisely determined position on the sheet metal. Such dowel holes were also previously produced in two successive process steps on two different machines since such dowel holes cannot be simply punched out. During punching, the material tears in a more or less pronounced manner in the lower area of the hole over about one third of the total depth of the /8 hole, depending on the material of the metal sheet; i.e. in its lower area, the hole has no exact cross section determined by the stamping punch, but much more often expands conically downward. In the past dowel holes that have a previously-determined exact fitting cross section over the entire sheet metal thickness could only be produced with a reamer on a drilling machine, e.g. forming dowel holes together with other sheet metal

work on an NC punching machine has not been possible to date.

Thus the object of the invention is to indicate a simple method with which countersunk holes or dowel holes can be produced in a metal sheet on one and the same machine, for example a usual NC punching machine, and to indicate a simple tool for carrying out such a method.

This object, producing countersunk holes in a metal sheet, is achieved according to the method of Claim 1, the production of dowel holes according to method Claim 2. Other advantageous designs of the method according to the invention, and especially relating to a single tool for carrying out such a method, result from the subclaims.

According to the method of the invention, in a metal sheet, or in an analogous manner naturally also in a different appropriate flat material, countersunk holes and dowel holes can be produced on one and the same NC punching machine; it is no longer necessary to transfer the sheet metal part that has been processed in the punching machine to another machine, e.g. a drilling machine, in order to subsequently carry out /9 there the countersink or the dowel hole drilling that was previously usual. Both the method according to the invention for producing the countersunk holes, as well as the method for producing the dowel holes is based on the same basic concept, namely to form the desired countersunk hole or dowel hole subsequently to a previous simple punching process by using a stamping process and due to a corresponding material displacement in the sheet metal. In order to prevent a deposit of sheet metal material on the stamping die because of cold welding during this stamping process, it is advantageous to lubricate the stamping die with oil and cool it

during the stamping process. This is preferably achieved exactly as with the punching tools by appropriate supply of an air-oil mixture; modern NC punching machines are already equipped for this.

With the method of the invention according to Claim 1, countersunk holes can be produced in a simple and inexpensive manner fully automatically, e.g. on an NC punching machine, without having a negative effect on the plane parallelism of the sheet metal sides in the area of this hole. It is only necessary to first punch out a somewhat larger hole in the sheet metal and then using a stamping die, the contour shape of which corresponds to the desired shape of the countersunk hole, to stamp the countersink and the associated hole that is somewhat smaller in diameter from this prepunched hole. In this case, in the area of the prepunched hole the sheet metal material is plastic and permanently deformed, a certain material flow is involved and the material on the edge of the prepunched hole is finally displaced by the stamping process in such a way that the cross section of the hole will be adapted to the shape of the stamping die. If this method is carried out, e.g. on an NC punching machine, in addition to the provided different punching tools it is sufficient to use a stamping tool according to the invention, /10 by which the desired countersunk holes can be stamped fully automatically in the sheet metal part together with the punching. In contrast to the known method, which consists of forming the countersink subsequently in a second cutting working step on another machine, the method according to the invention makes possible a reduction in working time of up to 90% for producing such countersunk holes. In addition, a countersunk hole

produced according to the invention has even greater strength and surface quality, which can be attributed to the material displacement that occurs during stamping. Also the stamping tool does not wear as is the case with the known cutting tools. According to the method of the invention, all different types of countersinks can be produced; all that is necessary is to use an appropriate stamping die. The method according to the invention also makes possible compliance with the tolerances specified for such countersinks since the quality of the countersunk hole is determined exclusively by the shape of the stamping die. Therefore with the method according to the invention, the tolerance specifications can also be better complied with than is the case with the cutting technology. The method according to the invention is also suitable for different types of sheet metal materials and sheet metal thicknesses; for example it can be used even for metal sheets starting from 0.5 mm thickness. With the method according to the invention, not only tip or flat countersinks can be produced according to standards, but also any specially shaped countersinks, if necessary even from both sides of the sheet metal. In the latter case, an appropriately shaped stamping die is provided on the underside, so that in one stamping process a countersink with the desired shape occurs on both sides of the sheet metal due to /11 material displacement from the prepunched hole. This method is mainly suitable for preparation of holes, into which a thread will then be cut and in which it is advantageous to somewhat countersink the hole edges so that no burrs projecting over the top side of the sheet metal will develop during the subsequent thread cutting process. The method according

to the invention also makes possible, for the first time, the production of countersinks that are not circular in top view, e.g. square or hexagonal, oval or in any other centric or eccentric shape, as can be necessary e.g. for holding specially shaped screw heads, etc. Here as well, it is sufficient to use only one corresponding stamping die.

In the same way, according to the method of the invention in Claim 2, dowel holes can be stamped in a metal sheet. In contrast, in this case a hole is first punched in the metal sheet that has a somewhat smaller diameter. The hole that tears out somewhat at the bottom during punching will then be formed to the desired dowel hole using a cylindrical stamping die, during which the material deformation that hereby occurs strengthens the edge of the hole and thereby improves the stability of such dowel holes. The inside of the dowel hole will also be extremely smooth because of the stamping process. According to this method, dowel holes can also be formed that have a predetermined cross section deviating from the circular.

The forming of the countersunk and dowel holes can naturally /12 also be carried out from the reverse side of the metal sheet if necessary. In this case all that is necessary is to equip the countering tool provided on the reverse side of the sheet metal, which is normally designed as a bottom die, with a correspondingly shaped fixed stamping die and coordinate with it an elastically-yielding stripper. In this case, the upper stamp actuated by the punch is active and/or the hold down is active as a bottom die. In this manner, if necessary a corresponding countersinking can be carried out on both sides of the sheet metal, namely

in that on one side an upper tool is provided with an appropriately shaped countersunk hole stamping die and on the opposite side, a corresponding countering tool with fixed stamping die is provided that is also formed according to the desired countersink. In this way, by using a single punch stroke, a countersink of any shape can be produced on both sides of the sheet metal, all that is necessary is to design the upper and lower strippers that are provided and assigned to the stamping dies appropriately and to ensure that the stamping dies acting on both sides do not contact each other at the end of the stroke.

According to a further development of the invention, an adjusting screw with associated adjusting scale is provided on the stamping tool. This is especially advantageous in connection with a stamping tool for carrying out the method according to the invention, but it is also suitable for other stamping tools, e.g. for a known tool for stamping buttons out of a metal sheet. Here as well, this advantageous equipment can be successfully used for fine adjustment of the countersinking depth of the stamping die, namely it makes it possible for the user to precisely adjust any desired countersinking depth directly on the stamping /13 tool used in the machine without having to remove the tool and, for example carrying out the adjustment on the outside with the usual measuring device or only being able to determine the correct countersinking depth after several attempts.

The invention will be explained in more detail in the following. /14

Fig. 1 shows the cross section through a stamping tool, as is suitable for carrying out a method according to the invention on a usual NC punching

machine and with stamping die retracted and for producing a countersunk hole.

Fig. 2 shows the same tool according to Fig. 1, but with countersunk stamping die at the end of the stamping process.

Fig. 3 shows a tool of the same type, but with a stamping die for a flat countersink.

Fig. 4 shows a tool for a dowel hole.

The stamping tool shown is similar to a punching tool used in NC punching machines; it consists of a die holder 2, which is arranged so that it glides in a hold down 5. A compression spring 3 is arranged between hold down 5 and the upper end of the die holder 2 that cooperates with the tappet 10 of the punching machine by way of pressure plates 4. The die holder 2 is screwed together with the upper pressure plate 4 and can glide in the lower pressure plate. The tool is mounted by way of the hold down 5 in a known way on an upper tool carrier 8 of the machine, on a lower carrier 9 of the machine a bottom die 7 is mounted. At the upper end of the die holder 2, a depth adjusting screw 1 is provided that can be finely adjusted manually using a vernier gauge. With it, it is possible to adjust the countersinking depth precisely according to the sheet metal thickness. At the lower end of the die holder 2, the actual stamping tool 6 is mounted, which with its cylindrical shaft is guided with narrow fit in the opening 12 of the hold down 5. In the exemplary embodiment /15 according to Fig. 1, the end of the stamping die 6 is designed for forming a hole with pointed countersink, i.e. on the cylindrical shaft of the stamping die 6; a conical mold section 13 connects that is formed according

to the desired pointed countersink. This conical mold section 13 transitions into a cylindrical mold section 14, the diameter of which corresponds to the hole diameter of the desired countersunk hole. The opening 15 of the bottom die 7 is selected with a cross section and a diameter such that the mold section 14 fits in it with slight play.

For producing a countersunk hole according to the invention in a metal sheet 11, first on the NC punching machine, at the desired location, a cylindrical hole 16 is punched by a previous punching process, the inner diameter of which is selected so it is somewhat larger than the inner diameter of the countersunk hole to be produced which is determined by the mold section 14. In practice, the diameter of this cylindrical prepunched hole 16 is selected about 10 to 40% greater than the diameter of the desired countersunk hole. The excess dimension of this hole 16 naturally depends on the type of countersink, the sheet metal material used, the sheet metal thickness, etc.; however this can be determined for any case very simply by the person skilled in the art, possibly by attempts. After the cylindrical hole 16 is punched according to Fig. 1, the stamping tool in the NC punching machine is brought into action and lowered by way of the tappet 10 of the die holder 2 with the stamping die 6, together with the hold down 5, is lowered downward in the direction of the sheet metal 11 until the hold down 5 comes in contact with its face side on the upper side of the sheet metal.

During the further lowering of the tappet 10, then only the /16
die holder 2 is further lowered and spring 3 is compressed; thus the spring pressure also determines the contact pressure of the hold down 5 on the

sheet metal surface. Finally, the stamping depth shown in Fig. 2 that is determined by the adjustment of the depth adjusting screw 1 is reached, the stamping die has deformed the edges of the hole 16 according to the contour shape of its mold sections 13 and 14 and the sheet metal material is displaced in the direction of the arrow 17 shown in Fig. 2, such that a countersunk hole 18 shown in Fig. 2 ultimately develops. Since during this material displacement process, a certain displacement into the sheet metal itself occurs, it is recommended that this stamping process is carried out before other punching work on the workpiece in order to prevent subsequent deformations of the other punching work by the stamping process. After the stamping die 6 is retracted by releasing tension on the spring 3, and finally also the retraction of the hold down 5, a countersunk hole 18 occurs, which in the ideal case has a cylindrical hole section corresponding to the diameter of the mold section 14 and a conical countersunk section corresponding to the shape of the mold section 13. In many cases, it is not absolutely necessary to shape a continuous cylindrical hole to the reverse side of the hole, for example it may be sufficient to form a countersunk hole 19, which also expands somewhat conically on the reverse side. In this case, no complete material displacement process occurs; the material is only partially displaced in the area of the lower edge of the prepunched hole 16. Such a countersunk hole 19 with little material deformation has the advantage that it can be formed at a small distance from other punches. Countersunk head /17 screws used in such countersunk holes 19 also contact the countersunk head and not the hole wall. However for rivet countersinks or special

countersinks, a complete deformation and production of a hole 18 corresponding to the stamping die is preferred. During the stamping process, the sheet metal 11 is tightly clamped between the face side of the hold down 5 and the upper side of the bottom die 7 and in fact the clamping pressure is determined by the spring 3. After the stamping die 6 is guided with very narrow play of e.g. only 1/100 mm in the associated opening of the hold down, during the stamping process the material is also not displaced upward over the upper side of the sheet metal, thereby a bead or a jumping on the edge of the countersink 18 and/or 19 is prevented. Also, on the reverse side of the sheet metal 11, a jumping is avoided because of the relatively narrow play between die opening 15 and mold section 14, for example this play is about 3/100 mm. In addition, the edges of the openings 12 and 15 are designed with very sharp edges. To maintain the parallelism of the upper and lower sides of the sheet metal, even in the area of the stamping, the bottom die 7 is preferably designed so it is curved upward somewhat, for example up to about 0.5° in the direction of the sheet metal.

Fig. 3 shows a different shape for the mold section of the stamping die 6, in the exemplary embodiment shown, this is formed so that a flat countersink 20 occurs. The stamping process including the preliminary punching of a larger hole 16 is as described in connection with Figs. 1 and 2, in this case the material does not flow diagonally outward as in the pointed countersink according to Fig. 1 and 2, but mainly downward and during the production of this flat countersink 20 it compresses /18 almost exclusively in the lower area, as is indicated by arrow 17 in Fig.

3.

If corresponding countersinks will be formed on both sides of the sheet metal, instead of bottom die 7 a countering tool with fixed stamping die is provided so that during lowering of the upper tool and the beginning of the stamping process the desired countersinks are formed automatically on both sides by the stamping die 6. The upper and lower stamping dies are adapted to each other in this case. The stamping die 6 does not necessarily have a circular cross section, if necessary the shaft section could have a rectangular cross section, for example if the countersink will also be rectangular. It is sufficient, as known with stamping tools, to adapt the opening 12 of the hold down to this stamp cross section, possibly also the opening 15 of the die even if the actual hole will have a cross section deviating from the circle and corresponding to the cross section 14. Countersinks that are eccentric with respect to the hole can also be produced in this way.

Fig. 4 shows a tool with a stamping die 23 for producing a dowel hole 22. In this case, the stamping die 23 is cylindrical to the end; its edges are preferably somewhat rounded. It is again guided in the opening 12 of the hold down 5 with narrow play. The opening 15 of the bottom die 7 is adapted to this stamp cross section.

Again, for producing the dowel hole 22, first a hole 21 is /19
punched in the metal sheet 11; but in this case with a somewhat smaller diameter than the desired later dowel hole 22. During punching of this hole 21, the material tears somewhat, usually in the lower third and thus the punched hole is not cylindrical throughout but, as shown in an

exaggerated way in Fig. 4, expanded somewhat conically at the bottom. The reduced dimension of the punched hole 21 in comparison to the final dimension of the dowel hole 22 is naturally oriented to the thickness of the sheet metal, the sheet metal material and the size of the hole; however the person skilled in the art can again easily determine this reduced dimension. The prepunched hole 21 is then formed in a subsequent stamping process by lowering of the stamping die 23; the stamping process proceeds the same way as described in connection with the countersunk hole according to Figures 1 to 3. When the stamping die 23 penetrates the prepunched hole 21, the material is again displaced to the side and downward; because of this the material is highly compressed on the wall of the hole. In this way a dowel hole 22 of high quality and precision is achieved. Here as well, during the stamping process the sheet metal 11 is held between hold down 5 and bottom die 7 and thereby curvatures on the upper side of the sheet metal are prevented in the edge area of the hole 22.

In order to prevent a material deposit on the stamping die 6 and/or 23 during the stamping process, and thus premature wear of the tool, during the stamping process preferably a suitable lubricant is supplied continuously as is known from punching tools of similar types. For this purpose, in the die holder 2 there is a hole 24 leading from its face side to the chamber 27 in the hold down 5, which when the tool is in use is flooded with a corresponding supply channel 26 in tappet 10. In /20 the hold down 5, corresponding channels 25 are also formed that open out in the wall of the hold down opening. In this way, lubricant can be supplied

to stamping die 6 by way of channel 26, hole 24, chamber 27 and channel 25, as shown in Fig. 1. In the same way, lubricant can naturally also be supplied to the stamping die according to Fig. 4. In NC punching machines, it is usual to supply an oil-air mixture for other purposes, as is explained for example in patent 26 37 085. According to the invention, the same oil-air mixture can be supplied by way of channel 26 for lubricating and cooling the stamping die 6 and/or 23.

The method according to the invention for producing dowel or countersunk holes can naturally also be used with other automatically operating machines, for example with eccentric presses, compressed air presses or hydraulic presses. An installation in so-called follow-on cutting tools is also possible. Remodeling of the machines is not necessary since the tool according to the invention will be used like a usual punching tool.

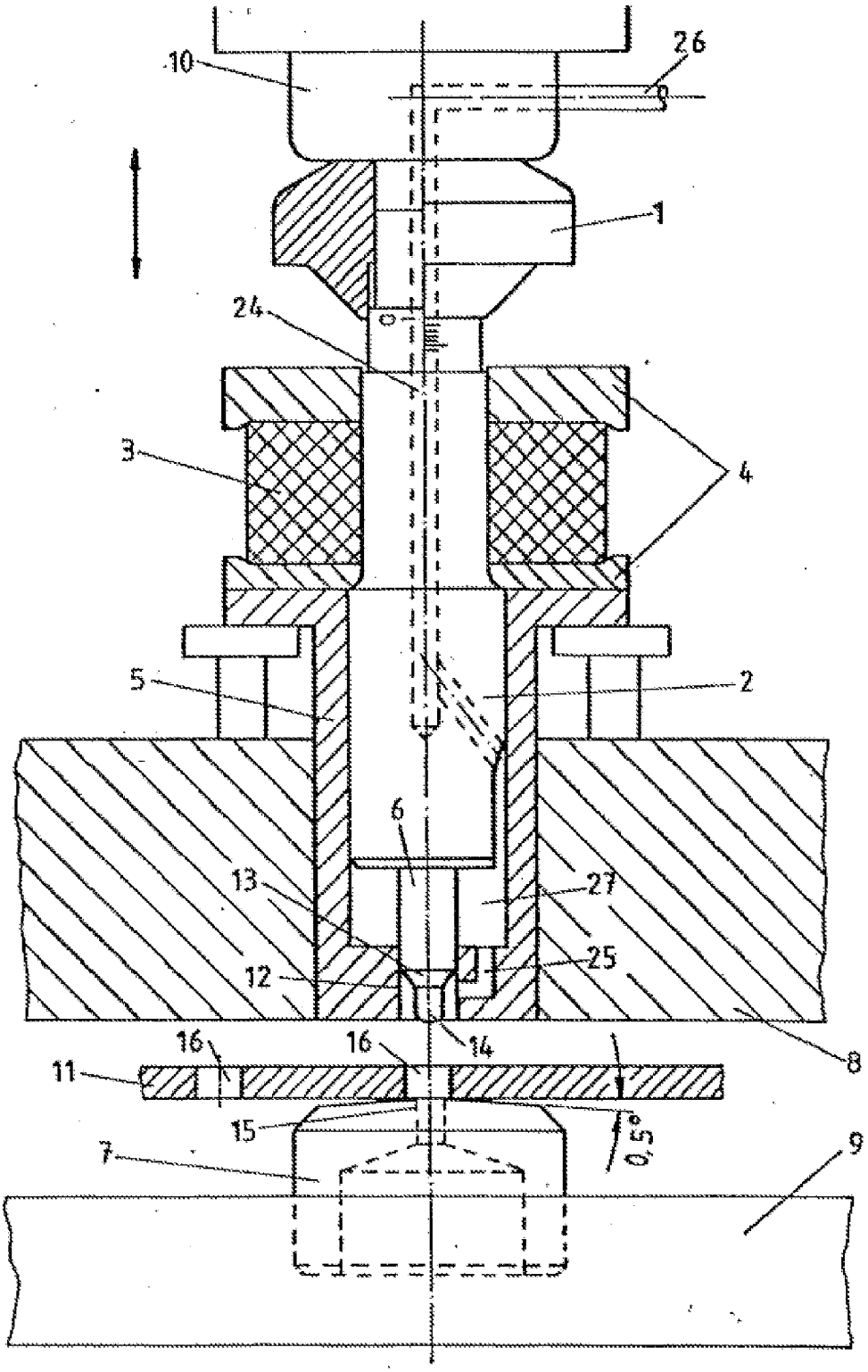

Fig. 1

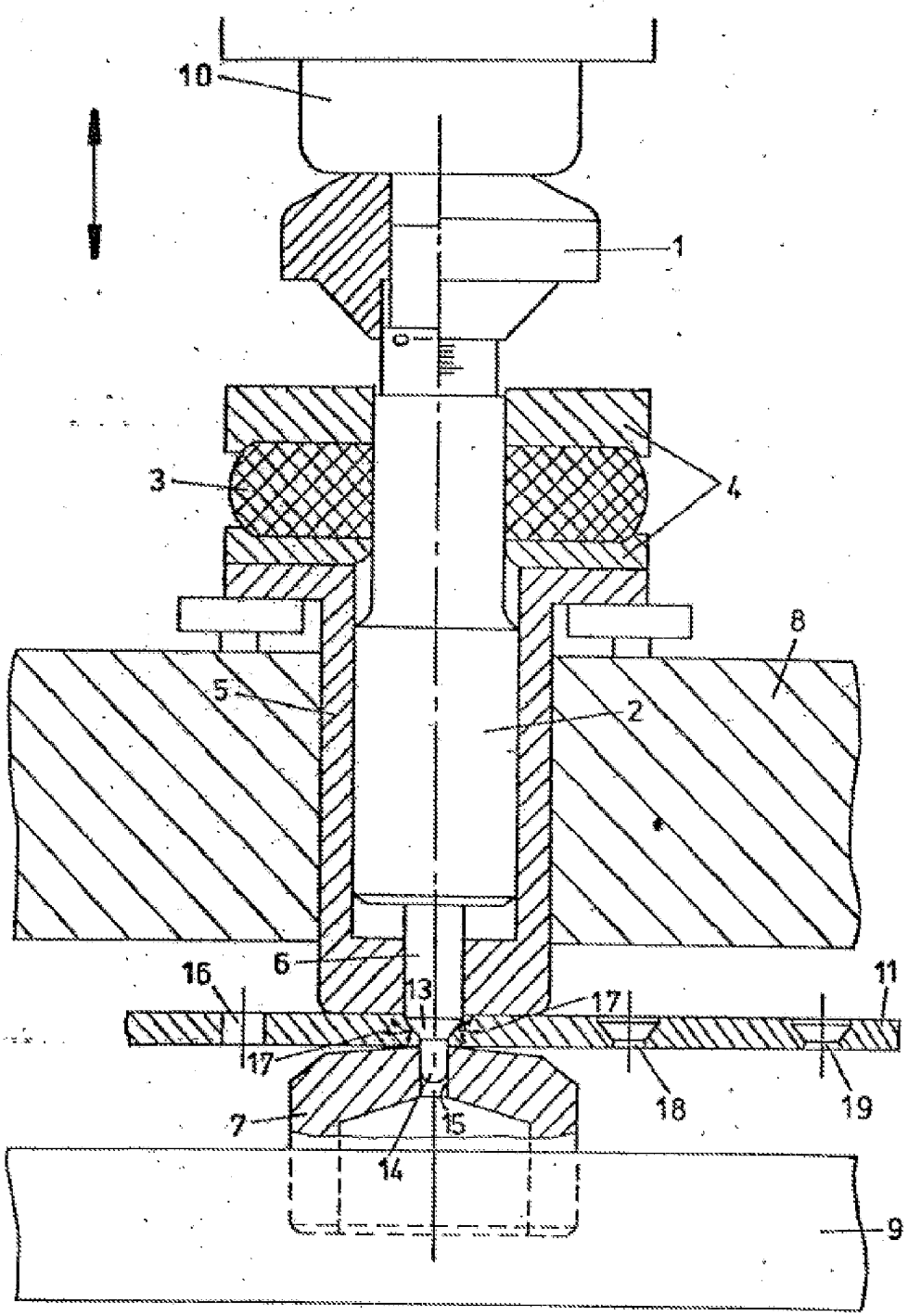

Fig. 2

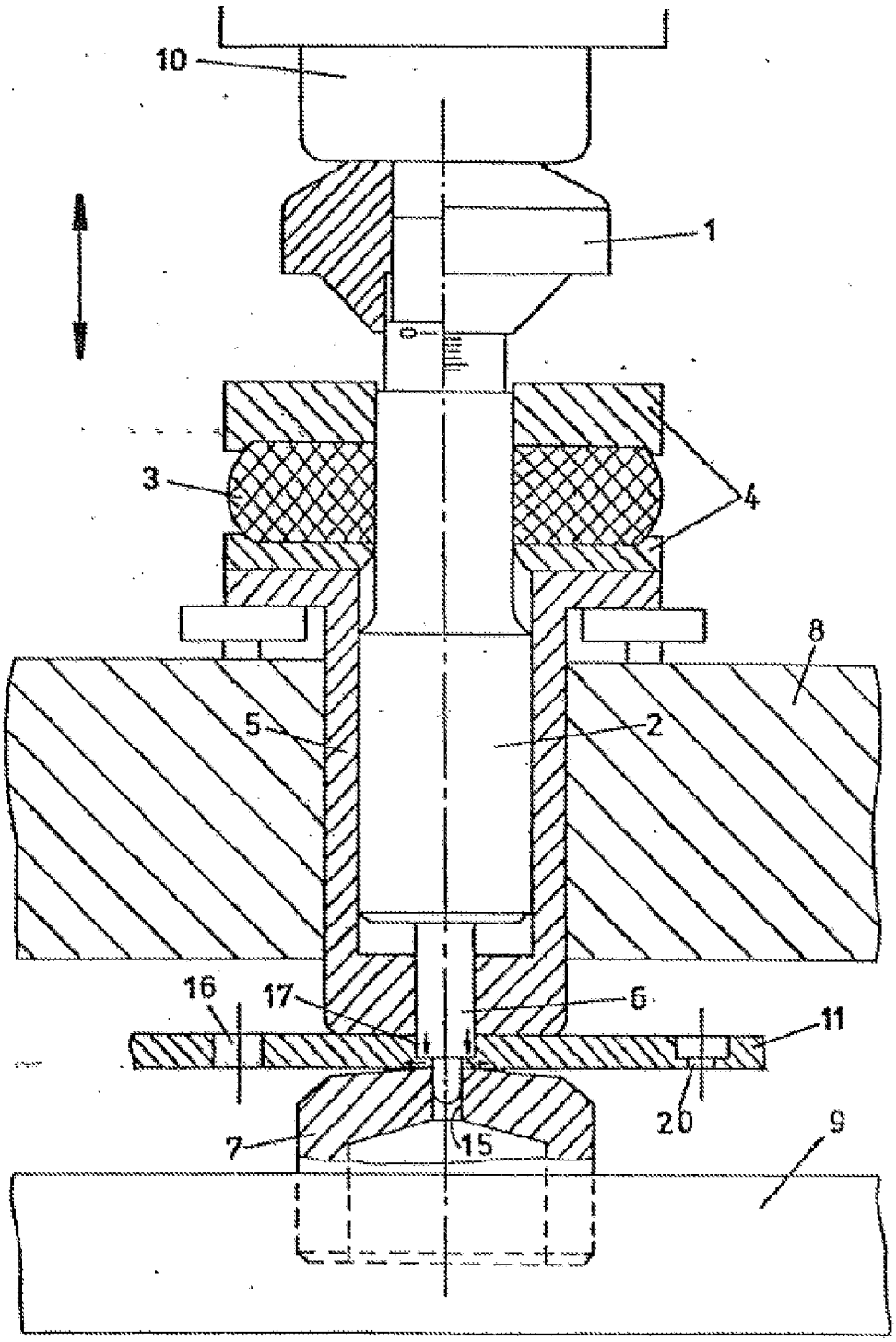

Fig. 3

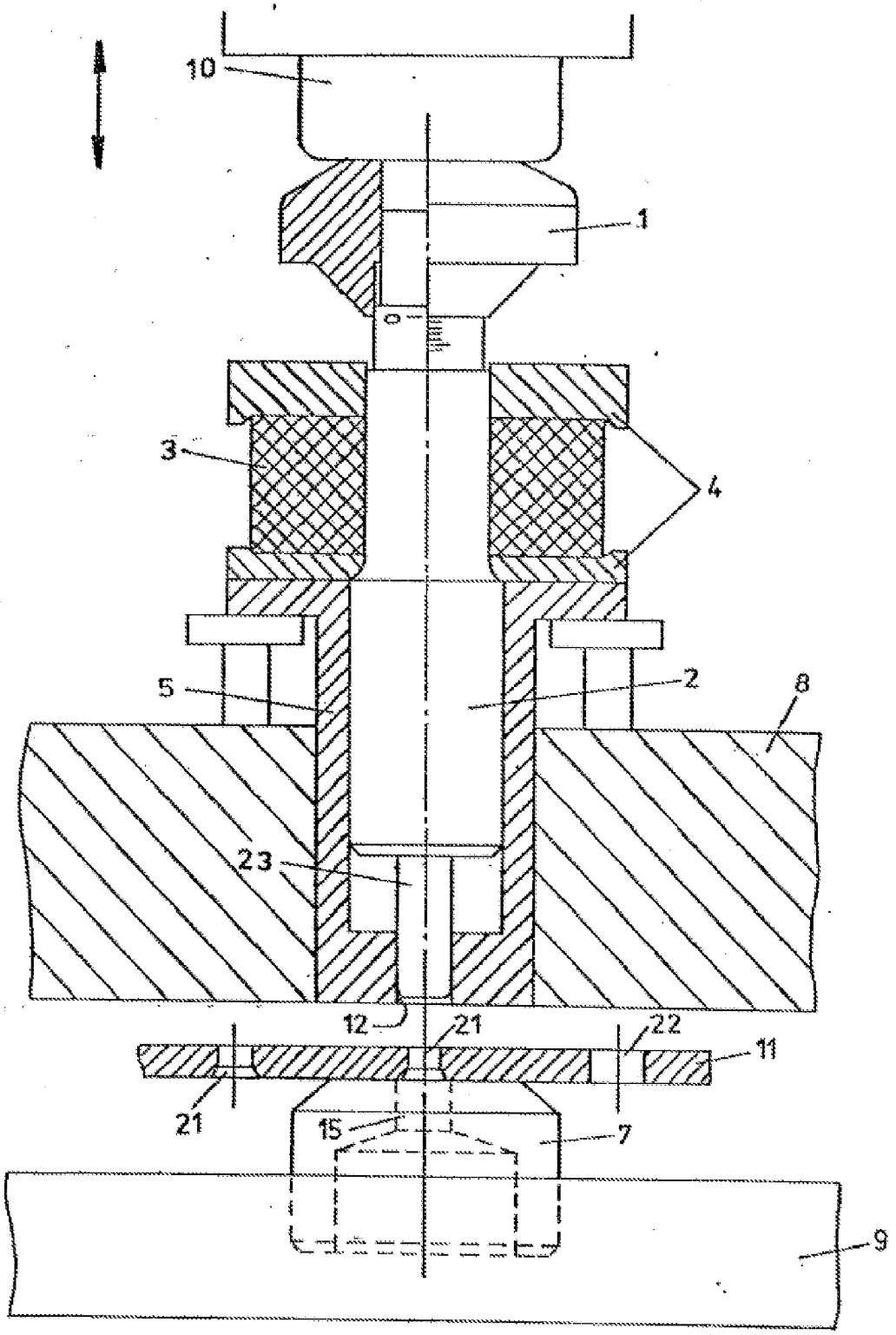

Fig. 4